CLAIMS

1. An inspection apparatus for inspecting an object to be inspected by irradiating either of charged particles or electromagnetic waves onto said object to be inspected, said apparatus comprising:

a working chamber for inspecting said object to be inspected, said chamber capable of being controlled to have a vacuum atmosphere;

a beam generating means for generating either of said charged particles or said electromagnetic waves as a beam;

an electronic optical system for guiding and irradiating said beam onto said object to be inspected held in said working chamber, detecting secondary charged particles emanated from said object to be inspected and introducing said secondary charged particles to an image processing system;

said image processing system for forming an image by said secondary charged particles;

an information processing system for displaying and/or storing status information of said object to be inspected based on output from said image processing system; and

a stage unit for operatively holding said object to be inspected so as to be movable with respect to said beam.

2. An inspection apparatus according to claim 1, further comprising a carrying mechanism for securely accommodating said object to be inspected and for transferring said object to or from said working chamber.

3. An inspection apparatus according to claim 2, wherein said carrying mechanism comprises:

a mini-environment chamber for supplying a clean gas to said object to be inspected to prevent dust from contacting to said object to be inspected;

at least two loading chambers disposed between said mini-environment chamber and said working chamber, and adapted to be independently controllable so as tohave a vacuum atmosphere; and

a loader having a carrier unit capable of transferring said object to be inspected between said mini-environment chamber and said loading chambers, and another carrier unit capable of transferring said object to be inspected between said one loading chamber and said stage device;

wherein said working chamber and said loading chamber are supported through a vibration isolator.

4. An inspection apparatus according to claim 1, wherein said inspection apparatus further comprising:

a precharge unit for irradiating a charged particle beam onto said object to be inspected placed in said working chamber to reduce variations in charge on said object to be inspected; and

a potential applying mechanism for applying a potential to said object to be inspected.

5. An inspection apparatus according to claim 3, wherein:

said loader includes:

a first loading chamber and a second loading chamber capable of independently controlling an atmosphere therein;

a first carrier unit for carrying said object to be inspected between said first loading chamber and the outside of said first loading chamber; and

a second carrier unit disposed in said second loading chamber for carrying said object to be inspected between said first loading chamber and said stage device.

6. An inspection apparatus according to claim 1,2 or 3, further comprising:

an alignment controller for observing the surface of said object to be inspected for the alignment of said object to be inspected with respect to said electron-optical system to control the alignment; and

a laser interferometry range finder for detecting coordinates of said object to be inspected on said stage device, said coordinates of said object to be inspected being determined by said alignment controller using patterns formed on said object to be inspected.

7. An inspection apparatus according to claim 1, 2 or 3, wherein the alignment of said object to be inspected includes:

rough alignment performed within said mini-environment space; and

alignment in XY-directions and alignment in a rotating direction performed on said stage device.

8. An inspection apparatus according to claim 1, 2 or 3, wherein said electron optical system includes:

an E x B separator for deflecting said secondary charged particle toward said detector by a field where an electric field and a magnetic field cross at right angles; and

an electrode for controlling the electric field intensity in a plane of said sample to be inspected, said plane being exposed to said electron beam irradiation, said electrode being arranged between said objective lens and said sample to be inspected, and having a shape approximately symmetrical with respect to the optical axis of irradiation of said beam.

9. An inspection apparatus according to claim 1, 2 or 3, wherein said apparatus includes an E x B separator, into which said charged particles and said secondary charged particles enter, said secondary charged particles being advanced in a direction approximately opposite to said charged particles, and in which said charged particles or said secondary charged particles are deflected selectively, said E x B separator characterized in that:

the electrodes for generating an electric field are made up of three or more pairs of non-magnetic conductive electrodes, and are arranged so as to approximately form a cylinder.

10. An inspection apparatus according to claim 1, 2 or 3, wherein said apparatus further comprises a charged particle irradiating section for irradiating charged particles in advance against said inspecting region just before the inspection.

11. An inspection apparatus according to claim 1, 2 or 3, wherein

said apparatus further comprises a means for uniforming a distribution or reducing the potential level of electric charge residing on said object.

12. An inspection apparatus according to claim 1, 2 or 3, wherein electrons having energy lower than that of said charged particles are supplied to said sample at least while said detector is detecting said the secondary charged particle image.

13. An inspection apparatus according to claim 1, 2 or 3, wherein said stage is an XY stage, said XY stage being accommodated in a working chamber and supported by a hydrostatic bearing in a non-contact manner with respect to said working chamber;

said working chamber in which said stage is accommodated being exhausted to vacuum; and

with a differential exhausting mechanism arranged surrounding a portion in said charged particle beam apparatus, where the charged particle beam is to be irradiated against a surface of said sample, so that a region on said sample to which said charged particle beam is to be irradiated may be exhausted to vacuum.

14. An inspection apparatus according to claim 1, 2 or 3, wherein said apparatus includes an apparatus for irradiating a charged particle beam against the surface of a sample loaded on an XY stage while moving said sample to a desired position in vacuum atmosphere,

said XY stage being provided with a non-contact supporting mechanism by means of a hydrostatic bearing and a vacuum sealing mechanism by means of differential exhausting, and

a divider is provided for making the conductance smaller between the charged particle beam irradiating region and the hydrostatic bearing support section, so that there is a pressure difference produced between said charged particle beam irradiating region and said hydrostatic bearing support section.

15. An inspection apparatus according to claim 1, 2 or 3, wherein said apparatus includes:

an image obtaining means for obtaining respective images for a plurality of regions to be inspected, said regions being displaced from one another while being partially superimposed one on another on said sample;

a storage means for storing a reference image; and a defect determination means for determining any defects in said sample by comparing said respective images obtained by said image obtaining means for said plurality of regions to be inspected with said reference images stored in said storage means.

16. A method of manufacturing a device comprising the steps of:

detecting defects on a wafer using an inspection apparatus according to any one of claims 1 to 15 in the middle of a process or subsequent to the process.

17. An inspection apparatus comprising:

a beam source for irradiating charged particles against a sample to be inspected;

a retarding-field type objective lens for decelerating said charged particles as well as for accelerating secondary charged particles generated by said electron beam irradiated against said sample to be inspected;

a detector for detecting said secondary charged particles;

an E x B deflecting system for deflecting said secondary charged particles toward said detector by a field where an electric field and a magnetic field cross at right angles; and

an electrode for controlling the electric field intensity in a plane of said sample to be inspected, said plane being exposed to said charged particle irradiation, said electrode being arranged between said retarding-field type objective lens and said sample to be inspected and having a shape approximately symmetrical with respect to the optical axis of irradiation of said charged particles.

18. An electron beam apparatus in accordance with claim 17, in which a voltage applied to said electrode is set to control said electric field intensity depending on the category of said sample to be inspected.

19. An electron beam apparatus in accordance with claim 17, in which said sample to be inspected is a semiconductor wafer, and said voltage applied to said electrode in order to control said electric field intensity is controlled

depending on whether or not said semiconductor device has a via.

20. A method for manufacturing a device using an electron beam apparatus defined by any of claims 17 to 19, said method characterized in that a semiconductor wafer, which has been prepared as said sample to be inspected, is inspected for defects by using said inspecting apparatus in a manufacturing processes of the device or subsequent to the process.

21. An E x B separator, into which a first charged particle beam and a second charged particle beam enter, said second charged particles being advanced in a direction approximately opposite to said first charged particle beam, and in which said first charged particle beam or said second charged particle beam is deflected selectively, said E x B separator characterized in that:

electrodes for generating an electric field are made up of three or more pairs of non-magnetic conductive electrodes, and are arranged so as to form a cylinder.

22. An E x B separator in accordance with claim 21, in which each of pair of parallel plate magnetic poles for generating a magnetic field is respectively arranged outside of said cylinder composed of said three or more pairs of non-magnetic conductive electrodes, and projections are formed in peripheral portions of the opposite face of each of said pair of parallel plate magnetic poles.

23. An E x B separator in accordance with claim 22, in

which in a passage space of lines of magnetic force of the magnetic field generated, a majority of the passage space other than that between said parallel plate magnetic poles is formed to be cylindrical in shape and coaxial with said cylinder composed of said three or more pairs of non-magnetic conductive electrodes.

24. An E x B separator in accordance with claim 22 or 23, in which said parallel plate magnetic poles are made of permanent magnets.

25. A defect inspection apparatus using the E x B separator defined by any of claims 21 to 24, in which

either one of said first charged particle beam or said second charged particle beam is a primary charged particle beam to be irradiated against a sample to be inspected, and the other is a secondary charged particle beam generated from said sample by the irradiation of said primary charged particle beam.

26. A projective type electron beam inspection apparatus, comprising a charged particle irradiating section, a lens system, a deflecting system, an E x B filter (Wiener filter), and a secondary charged particle detector, in which charged particles from said charged particle irradiating section are irradiated onto an inspecting region of a sample through said lens system, said deflecting system, and said E x B filter, and secondary charged particles emitted from the sample are formed into an image in said secondary charged particle detector by said lens system, said deflecting system, and said E x B

filter, and an electric signal thereof is inspected as the image, said apparatus characterized in further comprising a charged particle irradiating section for irradiating charged particles in advance against said inspecting region just before the inspection.

27. An apparatus in accordance with claim 26, in which said charged particles are selected from the group consisting of electrons, positive or negative ions, or plasma.

28. An apparatus in accordance with either of claim 26 or 27, in which the energy of said charged particles is equal to or less than 100eV.

29. An apparatus in accordance with either of claim 26 or 27, in which the energy of said charged particles is not greater than 30eV.

30. A method for manufacturing a device using an inspection apparatus defined by any of claims 26 to 29, in which a pattern inspection is performed in the device manufacturing processes.

31. An imaging apparatus which irradiates a charged particle beam emitted from a beam source against an object and detects secondary charged particles emanated from the object by using a detector so as to collect image data of said object, to inspect the object for defects and so forth,

said apparatus characterized in further comprising a means for uniforming the distribution or reducing the potential level of electric charge residing on said object.

32. An imaging apparatus in accordance with claim 31, in

which said means comprises an electrode disposed between said beam source and said object so as to be capable of controlling said electric charge.

33. An imaging apparatus in accordance with claim 31, in which said means is designed so as to be operative during the idle time between measurement timings.

34. An imaging apparatus in accordance with claim 31, in which said imaging apparatus further comprises:

at least one or more primary optical systems for irradiating a plurality of charged particle beams against said object; and

at least one or more secondary optical systems for guiding electrons emanated from said object to at least one or more detectors, wherein

each of said plurality of primary charged particle beams is respectively irradiated onto a spot such that a distance between any two spots is more than the distance resolution of said secondary optical system.

35. A device manufacturing method characterized in that a defect in a wafer is detected in the course of processes by using the imaging apparatus disclosed in either of claim 31 to 34.

36. An inspection apparatus for inspecting a sample for defects, comprising:

a charged particle irradiation means capable of irradiating primary charged particles against said sample;

a projecting means for projecting secondary charged particles emanated from said sample by the irradiation of

said primary charged particles so as to form an image;

a detection means for detecting an image formed by said projecting means as an electron image of said sample; and

a defect evaluation means for determining a defect in said sample based on an electron image detected by said detection means, wherein

electrons having energy lower than that of said primary charged particles are supplied to said sample at least while said detection means is detecting said electron image.

37. An inspection apparatus for inspecting a sample for defects, comprising:

a charged particle irradiation means capable of irradiating primary charged particles against said sample;

a projecting means for projecting secondary charged particles emanated from said sample by the irradiation of said primary charged particles so as to form an image;

a detection means for detecting an image formed by said projecting means as an electron image of said sample; and

a defect evaluation means for determining a defect in said sample based on an electron image detected by said detection means; and

UV photoelectron supply means capable of supplying UV photoelectrons to said sample.

38. An inspection method for inspecting a sample for defects, comprising:

an irradiating process for irradiating primary charged particles against said sample;

a projecting process for projecting secondary charged particles emanating from said sample by the irradiation of said primary charged particles so as to form an image;

a detecting process for detecting said image formed in said projecting process as an electron image of said sample; and

a defect evaluating process for determining a defect in said sample based on said electron image detected in said detecting process, wherein

electrons having energy lower than that of said primary charged particles are supplied to said sample at least while said electron image is being detected in said detecting process.

39. An inspection method for inspecting a sample for any defects, comprising:

an irradiating process for irradiating primary charged particles against said sample;

a projecting process for projecting secondary charged particles emanating from said sample by the irradiation of said primary charged particle so as to form an image;

a detecting process for detecting said image formed in said projecting process as an electron image of said sample; and

a defect evaluating process for determining a defect in said sample based on said electron image detected in said detecting process, said method further comprising:

a UV photoelectron supplying process for supplying said sample with UV photoelectrons.

40. A semiconductor manufacturing method including a process for inspecting for defects a sample to be required in manufacturing a semiconductor device by using an inspection apparatus defined in either of claim 36 or 37.

41. An apparatus for irradiating a charged particle beam against the surface of a sample loaded on an XY stage while moving said sample to a desired position in a vacuum atmosphere, said apparatus characterized in that:

said XY stage is provided with a non-contact supporting mechanism by means of a hydrostatic bearing and a vacuum sealing mechanism by means of differential exhausting, and

a divider is provided for making the conductance smaller between a charged particle beam irradiating region and a hydrostatic bearing support section, so that there is a pressure difference produced between said charged particle beam irradiating region and said hydrostatic bearing support section.

42. A charged particle beam apparatus in accordance with claim 41, in which said divider has a differential exhausting structure integrated therein.

43. A charged particle beam apparatus in accordance with either of claim 41 or 42, in which said divider has a cold trap function.

44. A charged particle beam apparatus in accordance with either of claim 41 to 43, in which said dividers are

arranged in two locations including in the proximity of the charged particle beam irradiating location and the proximity of the hydrostatic bearing.

45. A charged particle beam apparatus in accordance with any of claims 41 to 44, in which the gas supplied to the hydrostatic bearing of said stage is nitrogen or an inert gas.

46. A charged particle beam apparatus in accordance with any of claims 41 to 45, in which a surface treatment is applied to at least the surface of a part facing the hydrostatic bearing in said XY stage so as to reduce the amount of gas to be desorbed.

47. A wafer defect inspection apparatus for inspecting the surface of a wafer for defects by using the apparatus disclosed in any of claim 41 to 46.

48. An exposing apparatus for delineating the circuit pattern of a semiconductor device on the surface of a semiconductor wafer or a reticle by using the apparatus disclosed in any of claims 41 to 46.

49. A semiconductor manufacturing method for manufacturing a semiconductor by using the apparatus disclosed in any of claims 41 to 48.

50. An inspection apparatus or inspection method for inspecting a sample for defects, comprising;

an image obtaining means for obtaining respective images of a plurality of regions to be inspected, said regions being displaced from one another while being partially superimposed one on another on said sample;

a storage means for storing a reference image; and

a defect determination means for determining defects in said sample by comparing said respective images obtained by said image obtaining means for said plurality of regions to be inspected with said reference image stored in said storage means.

51. An inspection apparatus or inspection method in accordance with claim 50, said apparatus further comprising a charged particle irradiation means for irradiating a primary charged particle beam against each of said plurality of regions to be inspected so that a secondary charged particle beam is emitted from said sample, wherein

said image obtaining means obtains images of said plurality of regions to be inspected in order by detecting said secondary charged particle beam emitted from said plurality of regions to be inspected.

52. An inspection apparatus or inspection method in accordance with claim 51, in which said charged particle irradiation means comprises a particle source for emitting primary charged particles and a deflecting means for deflecting said primary charged particles, wherein

said deflecting means deflects said primary charged particles emitted from said particle source so as to be irradiated against said plurality of regions to be inspected in order.

53. An inspection apparatus or inspection method in accordance with any of claims 50 to 52, said apparatus comprising a primary optical system for irradiating a

primary charged particle beam against a sample and a secondary optical system for guiding secondary charged particles to a detector.

54. A semiconductor manufacturing method including a process for inspecting a finished wafer or an wafer under processing for defects by using an inspection apparatus in accordance with any of claims 50 to 53.

55. A charged particle beam apparatus for irradiating a charged particle beam against a sample loaded on an XY stage, said apparatus characterized in that:

said XY stage is accommodated in a housing and supported by a hydrostatic bearing in a non-contact manner with respect to said housing;

said housing in which said stage is accommodated is exhausted to vacuum; and

a differential exhausting mechanism is arranged surrounding a portion in said charged particle beam apparatus, where the charged particle beam is to be irradiated against a surface of said sample, so that a region on said sample to which said charged particle beam is to be irradiated may be exhausted to vacuum.

56. A charged particle beam apparatus in accordance with claim 55, in which a gas to be supplied to said hydrostatic bearing of said XY stage is nitrogen or an inert gas, and said nitrogen or inert gas is pressurized after having been exhausted from said housing containing said stage so as to be supplied again to said hydrostatic bearing.

57. A wafer inspection apparatus for inspecting a surface

of a semiconductor wafer for defects by using the apparatus in accordance with either of claim 55 or 56.

58. An exposing apparatus for delineating the circuit pattern of a semiconductor device on the surface of a semiconductor wafer or a reticle by using the apparatus in accordance with either of claim 55 or 56.

59. A semiconductor manufacturing method for manufacturing a semiconductor by using the apparatus in accordance with either of claims 55 to 58.

60. An inspection method for inspecting an object to be inspected by irradiating either charged particles or electromagnetic waves onto said object to be inspected by using an apparatus comprising:

a working chamber for inspecting said object to be inspected, said chamber capable of being controlled to have a vacuum atmosphere;

a beam source for emitting either said charged particles or said electromagnetic waves as a beam;

an electronic optical system for guiding and irradiating said beam onto said object to be inspected held in said working chamber, detecting secondary charged particles emanating from said object to be inspected and introducing said secondary charged particles to an image processing system;

said image processing system for forming an image by said secondary charged particles;

an information processing system for displaying and/or storing status information of said object to be

inspected based on output from said image processing system; and

a stage unit for operatively holding said object to be inspected so as to be movable with respect to said beam, said method comprising the steps of:

positioning said beam accurately onto said object to be inspected by measuring the position of said object to be inspected;

deflecting said beam onto a desired position of said measured object to be inspected;

irradiating said desired position on the surface of said object to be inspected by said beam;

detecting secondary charged particles emanating from said object to be inspected;

forming an image by said secondary charged particles; and

displaying and/or storing status information of said object to be inspected based on output from said image processing system.